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Sertifikaat

REPUBLIEK VAN SUID-AFRIKA

Certificate

REPUBLIC OF SOUTH AFRICA

PATENT KANTOOR
DEPARTEMENT VAN HANDEL
EN NYWERHEID

PATENT OFFICE
DEPARTMENT OF TRADE AND
INDUSTRY

Hiermee word gesertifiseer dat
This is to certify that

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the documents annexed hereto are true copies of:

Application forms P.1 and P.3,provisional specification and drawings of South African Patent Application No. 2003/6376 as originally filed in the Republic of South Africa on 15 August 2003 in the name of PEBBLE BED MODULAR REACTOR (PROPRIETARY) LIMITED for an invention entitled: "A SUPPORT ARRANGEMENT ".

PRIORITY DOCUMENT
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Geteken te PRETORIA in die Republiek van Suid-Afrika, hierdie 3th dag van June 2004
in the Republic of South Africa, this 3th day of June 2004

Registrar of Patents

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978
APPLICATION FOR A PATENT AND
ACKNOWLEDGEMENT OF RECEIPT
(Section 30(1) Regulation 22)

REPUBLIC OF SOUTH AFRICA
FORM P.1 REVENUE
(to be lodged in duplicate)

15.08.03 R 060.00

INKOMSTE
REPUBLIEK VAN SUID AFRIKA

THE GRANT OF A PATENT IS HEREBY REQUESTED BY THE UNDERMENTIONED APPLICANT ON THE BASIS OF THE PRESENT APPLICATION FILED IN DUPLICATE

21	01	PATENT APPLICATION NO 2003/6376

A&A REF: P37589

71	FULL NAME(S) OF APPLICANT(S)

PEBBLE BED MODULAR REACTOR (PROPRIETARY) LIMITED

ADDRESS(ES) OF APPLICANT(S)

3rd Floor, Lake Buena Vista Building, 1267 Gordon Hood Avenue, Centurion, 0046, Republic of South Africa

54	TITLE OF INVENTION

A SUPPORT ARRANGEMENT

Only the items marked with an "X" in the blocks below are applicable.

[ ] THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANYING FORM P.2. The earliest priority claimed is Country: No: Date:

[ ] THE APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO 21 01

[ ] THIS APPLICATION IS A FRESH APPLICATION IN TERMS OF SECTION 37 AND BASED ON APPLICATION NO 21 01

THIS APPLICATION IS ACCOMPANIED BY:

X	A single copy of a provisional specification of 16 pages
X	Drawings of 7 sheets
	Publication particulars and abstract (Form P.8 in duplicate) (for complete only)
	A copy of Figure of the drawings (if any) for the abstract (for complete only)
X	An assignment of invention
	Certified priority document(s). (State quantity)
	Translation of the priority document(s)
	An assignment of priority rights
	A copy of Form P.2 and the specification of RSA Patent Application No 21 01
X	Form P.2 in duplicate
X	A declaration and power of attorney on Form P.3
	Request for ante-dating on Form P.4
	Request for classification on Form P.9
	Request for delay of acceptance on Form P.4
	Extra copy of informal drawings (for complete only)

REGISTRAR OF PATENTS DESIGNS, TRADE MARKS AND COPYRIGHT
2003 -08- 15
REGISTRATEUR VAN PATENTE, MODELLE, HANDELSMERKE EN OUTEURSREG

74	ADDRESS FOR SERVICE: Adams & Adams, Pretoria

Dated this 15th day of August 2003

ADAMS & ADAMS
APPLICANTS PATENT ATTORNEYS

The duplicate will be returned to the applicant's address for service as proof of lodging but is not valid unless endorsed with official stamp

A&A P201

OFFICIAL DATE STAMP
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2003 -08- 15
REGISTRATEUR VAN PATENTE, MODELLE, HANDELSMERKE EN OUTEURSREG
REGISTRAR OF PATENTS

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PRETORIA

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978
DECLARATION AND POWER OF ATTORNEY
(Section 30 - Regulation 8, 22(i)(c) and 33)

FORM P.3

PATENT APPLICATION NO		
21	01	2003/6376

A&A Ref: V15876

LODGING DATE	
22	15 August 2003

FULL NAME(S) OF APPLICANT(S)	
71	PEBBLE BED MODULAR REACTOR (PROPRIETARY) LIMITED

FULL NAME(S) OF INVENTOR(S)	
72	FORTIER, Fredrik Alfried

EARLIEST PRIORITY CLAIMED	COUNTRY		NUMBER		DATE	
	33	---	31	---	32	---

NOTE: The country must be indicated by its International Abbreviation - see schedule 4 of the Regulations

TITLE OF INVENTION	
54	A SUPPORT ARRANGEMENT

* I/We NICHOLLS, David Richard

hereby declare that :-

1. ~~I/we am/are the applicant(s) mentioned above~~;

** 2. I/we have been authorized by the applicant(s) to make this declaration and have knowledge of the facts herein stated in the capacity of Authorised Signatory of the applicant(s);

*** 3. the inventor(s) of the abovementioned invention is/are the person(s) named above and the applicant(s) has/have acquired the right to apply by virtue of an assignment from the inventor(s);

4. to the best of my/our knowledge and belief, if a patent is granted on the application, there will be no lawful ground for the revocation of the patent;

**** 5. ~~this is a convention application and the earliest application from which priority is claimed as set out above is the first application in a convention country in respect of the invention claimed in any of the claims~~; and

6. the partners and qualified staff of the firm of **ADAMS & ADAMS**, patent attorneys, are authorised, jointly and severally, with powers of substitution and revocation, to represent the applicant(s) in this application and to be the address for service of the applicant(s) while the application is pending and after a patent has been granted on the application.

SIGNED THIS 15th DAY OF May 2003

Company Name: **PEBBLE BED MODULAR REACTOR (PROPRIETARY) LIMITED**
Full Names: NICHOLLS, David Richard
Capacity: AUTHORISED SIGNATORY

(no legalization necessary)

* In the case of application in the name of a company, partnership or firm, give full names of signatory/signatories, delete paragraph 1, and enter capacity of each signatory in paragraph 2.
** If the applicant is a natural person, delete paragraph 2.
*** If the right to apply is not by virtue of an assignment from the inventor(s), delete "an assignment from the inventor(s)" and give details of acquisition of right.
**** For non-convention applications, delete paragraph 5.

A&A P203

A & A Ref No: V15876 2003/6376

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FORM P6

REPUBLIC OF SOUTH AFRICA
Patents Act, 1978

PROVISIONAL SPECIFICATION

(Section 30 (1) - Regulation 27)

21	01	OFFICIAL APPLICATION NO

2003/6376

22	LODGING DATE

15 August 2003

71	FULL NAME(S) OF APPLICANT(S)

PEBBLE BED MODULAR REACTOR (PROPRIETARY) LIMITED

72	FULL NAME(S) OF INVENTOR(S)

FORTIER, Fredrik Alfried

54	TITLE OF INVENTION

A SUPPORT ARRANGEMENT

A&A P206

THIS INVENTION relates to a support arrangement. It also relates to a method of supporting a vessel.

A problem which is encountered is the support of vessels which are subjected to temperature fluctuations. As a result of changes in temperature the shape of the vessel may change and this can lead to undesirable stresses in the vessel and/or in the vessel support.

According to one aspect of the invention there is provided a support arrangement which includes

a vessel;

a single vertical support for supporting the weight of the vessel; and

lateral support means positioned at an elevation which is above that of the single vertical support for providing lateral support to the vessel.

The Inventor believes that the invention will find application particularly, though not necessarily exclusively, in a high temperature gas cooled nuclear reactor which includes a support arrangement in the form of a reactor pressure vessel within which a vessel in the form of a core barrel assembly is housed. The core barrel is supported by the reactor

pressure vessel and hence the entire weight of the core barrel and its contents is transmitted to the reactor pressure vessel.

The vertical support may include upper and lower support members which are connected respectively to the core barrel and the reactor pressure vessel, between which vertical loads are transmitted.

In one embodiment of the invention, the support members may define centrally positioned oppositely disposed contact surfaces.

The upper support member may include a central member which extends downwardly from the bottom of the core barrel and a plurality of angularly spaced support beams connected to the bottom of the core barrel and to the central member and extending radially outwardly from the central member.

At least one of the contact surfaces may be curved so that relative movement between the contact surfaces is achieved by rolling and not sliding thereby reducing the risk of welding of the surfaces when operating in a helium environment. In a preferred embodiment of the invention both of the contact surfaces are curved.

The upper support member may define a downwardly facing concave contact surface. The lower support member may define an upwardly facing convex contact surface. The contact surfaces may be part spherical. In a preferred embodiment of the invention, the radius of the convex support surface is smaller than that of the concave support surface.

In another embodiment of the invention, an intermediate member may be interposed between the upper and lower support members. The

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intermediate member may define upper and lower contact surfaces which cooperate, respectively, with complementary contact surfaces of the upper and lower support members.

The contact surfaces of the intermediate member may be convex with the complementary contact surfaces of the upper and lower support members being concave. In a preferred embodiment of the invention, each convex support surface has a radius which is smaller than that of the complementary concave support surface.

The lateral support means may include a plurality of circumferentially spaced lateral supports positioned to support the core barrel at or towards an operatively upper end thereof.

Each lateral support may include sets of inner and outer support members connected to the core barrel and the reactor pressure vessel respectively.

At least one of the inner and outer support members of each set may be mounted on a resiliently deformable support.

A roller element may be sandwiched between the inner and outer support members to facilitate relative displacement between the inner and outer support members and hence between the core barrel and the reactor pressure vessel. The roller and at least one of the inner and outer support members may be provided with complementary teeth to ensure that relative displacement between the roller and complementary bearing surfaces of the inner and outer support members is by rolling and not sliding. Instead of making use of the rollers, the bearing surfaces may be treated to inhibit welding in the event of relative sliding therebetween. This treatment may include nitriding of the bearing surfaces.

The bearing surfaces of the inner and outer support members may be inclined. In particular, the bearing surfaces of the inner and outer support members may be generally parallel and inclined outwardly upwardly.

Each outer support member may be mounted on a resiliently deformable support which, in turn, is mounted on an upper support ring secured to the reactor pressure vessel. The resiliently deformable support may include a pair of support posts connected to the upper support ring at spaced apart positions and an elastically deformable guide beam which extends between the support posts and on which the outer support member is mounted. The position of the guide beam and hence the relative positions of the inner and outer support members may be adjustable.

The reactor may include auxiliary support means for supporting the core barrel within the reactor pressure vessel when subjected to exceptional loads, eg as a result of a seismic event.

The auxiliary support means may include a lower auxiliary support including a plurality of circumferentially spaced radially inwardly facing slots in which radially outer ends of the support beams are received with little clearance. The slots may be defined on a radially inner surface of a lower support ring secured to the reactor pressure vessel. Shims may be used to obtain the desired clearance.

The auxiliary support means may include an upper auxiliary support. The upper auxiliary support may include a plurality of circumferentially spaced ribs connected to and protruding outwardly from the core barrel and complementary slots within which at least portions of

the ribs are received with little clearance. The slots may be provided on and open out of an inner surface of the upper ring. Shims may be provided to obtain the desired clearance.

According to another aspect of the invention there is provided a method of supporting a vessel which includes the steps of

transmitting the weight of the vessel and its contents to a support arrangement through a single vertical support; and

supporting the vessel laterally at a position which is at an elevation above that of the vertical support.

In the case of a nuclear reactor which includes a support arrangement in the form of a reactor pressure vessel and a vessel in the form of a core barrel contained within the reactor pressure vessel the method may include

transmitting the weight of the core barrel and its content to the reactor pressure vessel through a single vertical support; and

supporting the core barrel laterally at a position which is at an elevation above that of the vertical support.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings:

Figure 1 shows a schematic layout of a nuclear reactor incorporating a support arrangement in accordance with the invention;

Figure 2 shows a sectional view of a lower part of the nuclear reactor;

Figure 3 shows a three-dimensional view from below of a lower end of the core barrel forming part of the nuclear reactor and illustrating part of a vertical support;

Figure 4 shows, on an enlarged view, a three-dimensional view of part of a lower auxiliary support of the reactor;

Figure 5 shows a three-dimensional view of a lower portion of the reactor pressure vessel of the reactor illustrating the position of a lower support ring within the reactor pressure vessel;

Figure 6 shows a three-dimensional view of a shim mountable on the lower support ring;

Figure 7 shows a three-dimensional view of an upper end of the core barrel;

Figure 8 shows a three-dimensional view of part of an upper support ring which is mounted on the reactor pressure vessel;

Figure 9 shows a three-dimensional exploded view of part of lateral support in accordance with the invention;

Figure 10 shows a three-dimensional exploded view of a guide post mounted on the upper support ring; and

Figure 11 shows a three-dimensional view of part of the upper auxiliary support.

In the drawings, reference numeral 10 refers generally to a nuclear reactor incorporating a support arrangement in accordance with the invention. The reactor 10 includes a reactor pressure vessel 12 and a core barrel, generally indicated by reference numeral 14, contained within the reactor pressure vessel 12. The reactor 10 further includes a single vertical support, generally indicated by reference numeral 16, for transmitting vertical load from the core barrel to the reactor pressure vessel and lateral support means, generally indicated by reference numeral 18 (Figure 7) for providing lateral support to the core barrel 14.

The reactor pressure vessel 12 comprises a circular cylindrical side wall 20 and domed upper and lower ends 22, 24 respectively.

The core barrel 14 includes a circular cylindrical side wall 26, a top 28 and a bottom 30. Positioned in the core barrel 14 are reflectors 32 (not shown) which define between them a core or chamber 40 within which nuclear fuel is received.

The operational detail of the reactor and the associated structural features are not essential to the understanding of the invention and are not shown or described in detail.

Referring now in particular to Figures 2, 3 and 5 of the drawings, the vertical support 16 includes an upper support member 44 and a lower support member 46.

The upper support member 44 includes a circular cylindrical centre member 48 which is connected to the bottom 30 of the core barrel 14 and extends downwardly therefrom coaxially with the core barrel 14. The centre member 48 defines a downwardly facing concave contact surface 50. The contact surface 50 is recessed so that it is surrounded by an annular shoulder 52. The upper support member 44 further includes a plurality of angularly spaced support beams 54 connected to the bottom 30 of the core barrel 14 and to the central member 48 and extending radially outwardly therefrom. Hence, the support beams 54 provide support to the bottom 30 and to the central member 48 and serve to transfer the weight of the core barrel 14 to the central member 48.

The lower support member 46 as can best be seen in Figures 2 and 5 of the drawings, comprises a base 56 which is secured to the lower end 24 of the reactor pressure vessel 12 and a centrally disposed circular cylindrical portion 58 which protrudes upwardly from the base and defines a convex contact surface 60. The support member 46 is bolted to the reactor pressure vessel. These bolts do not have very large loads in view

of the fact that it is the weight of the core barrel assembl[illegible] transmitted through the vertical support 16 and the load is h[illegible] vertical downward direction. The diameter of the protruding pc[illegible] smaller than the internal diameter of the annular shoulder 52 su[illegible] receivable therein with clearance. Further, the contact surface [illegible] radius of curvature which is larger than that of the contact surf[illegible] one embodiment of the invention, the contact surface 50 has a [illegible] 5250 mm and the contact surface 60 has a radius of 4400 mm. [illegible] however, these radii may vary depending on the dimensions of t[illegible] and the optimum for a particular application can be determined [illegible] experimentation. The curved surfaces are provided in order [illegible] that relative movement occurs by rolling and not sliding. In ad[illegible] relatively large radii are used in order to achieve a desired conta[illegible]

As can best be seen in Figures 7, 8 and 12 of the dra[illegible] upper ring 72 is secured in position in the reactor pressure ve[illegible] this regard, one or more torsion keys 74 may be used to secu[illegible] 72 in position. As can most clearly be seen in Figure 12 of the [illegible] the ring 72 and pressure vessel 12 are provided with comp[illegible] downwardly radially inwardly tapering surfaces 73, 75. In ac[illegible] annular locking plate 77 is secured to the support ring 72 by [illegible] bolts, a radially outer edge portion of the locking plate 77 being [illegible] an annular recess 79 in the reactor vessel 12. This arrangemen[illegible] lock the ring 72 in position without the need for welding to the [illegible] the reactor pressure vessel 12.

The lateral support means 18 includes a pl[illegible] circumferentially spaced lateral supports 76 positioned to suppo[illegible] barrel 14 at or towards an operatively upper end thereof. With [illegible] also to Figure 9 of the drawings, each lateral support 76 includ[illegible] support member 78 and an outer support member 80. The in[illegible]

members 78 are secured to the core barrel 14 and the outer support members 80 are connected to the upper ring 72 as described in more detail herebelow. The support members 78, 80 define complementary inclined support or bearing surfaces 82, 84 which bear against a roller 86 positioned between the support members 78, 80. The roller 86 includes a circular cylindrical body 88 having a centrally disposed annular recess 90 therein. Further, a gear wheel 92 is provided at each end of the body and a circular cylindrical axial projection 94 projects from each of the gear wheels 92. Each of the inner and outer support members 78, 80 is provided with a centrally disposed rib 96 which protrudes from the surfaces 82, 84 and is receivable in the recess 90. Further, on each side of each of the surfaces 82, 84 a set of gear teeth 98 complementary to those of the gear wheels 92 is provided. This arrangement serves to ensure that relative displacement of the inner support member 78 and outer support member 80 is achieved as a result of rolling of the roller 86. Further, each outer support member 80 has a pair of cheek plates 100 which has a slot 102 provided therein. The slots 102 are parallel with the surface 84. The projections 94 are received with little clearance in the slots 102 and serve to restrict the extent of the movement of the roller 86 relative to the outer support member 80.

Each outer support member 80 is mounted on a resiliently deformable support, generally indicated by reference numeral 104 (Figure 8). Each support 104 includes a pair of guide posts 106 mounted on the upper ring 72 and an elastically deformable guide beam 108 which extends between the support posts 106.

As can best be seen in Figure 10 of the drawings, each support post 106 includes a base 110 which is secured to the upper ring 72 by welding and a slider 112. The base 110 and slider 112 have complementary lip and channel formations 113, 115 which permit relative

displacement of the slider 112 on the base 110 in a vertical direction. Complementary semi-circular recesses 114, 116 are provided on the base 110 and the slider 112, respectively which together form a hole within which part of an adjusting screw 118 is positioned. The recess 116 is provided with a screw thread. Vertical displacement of the adjusting screw 118 is inhibited by a cover plate 120 which is mounted on the support base and held in position by screws 122. The cover plate 120 cooperates with a collar 124 on the adjusting screw 118 to inhibit vertical displacement of the adjusting screw 118. The cover plate 120 also serves to hold the slider 112 captive on the base 110 and permit a limited degree of vertical displacement of the slider 112 relative to the base 110 by rotation of the adjusting screw 118. The slider 112 defines a slot 126 within which an end portion of a guide beam 108 is receivable. The guide beam is accordingly supported on a pair of support posts 106 and is configured to permit a degree of resilient displacement of the guide beam 108, in the manner of a leaf spring, and hence the outer support member 80 mounted thereon. Further, by adjusting the adjusting screws 118, the position of the guide beam and hence of the outer support member 80 relative to the inner support member 78 can be adjusted to obtain a desired preload. In the embodiment shown, the guide beams 108 are curved in order to fit within the space defined between the core barrel and the reactor pressure vessel.

As will be described in more detail herebelow, the vertical support 16 and lateral support means 18 serve to support the core barrel 14 within the reactor pressure vessel 12 under normal operating conditions. However, the possibility exists that the reactor 10 is subjected to exceptional loads, e.g. as a result of a seismic event. The reactor 10 accordingly includes auxiliary support means. The auxiliary support means includes a lower auxiliary support, generally indicated by reference

numeral 130 (Figures 3 and 4) and an upper auxiliary support, generally indicated by reference numeral 132 (Figure 11).

The lower auxiliary support 130 includes a lower support ring 134 which is secured to the reactor pressure vessel 12 adjacent to a lower end of the core barrel 14. The lower support ring 134 may be secured in position in the reactor pressure vessel 12 in a similar fashion to the upper support ring 72 as described above. . A plurality of radially inwardly open slots 138 is provided at circumferentially spaced positions on the lower support ring 134. Radially outer end portions of the support beams 54 are received within the slots 138.

The upper auxiliary support 132 includes a plurality of circumferentially spaced ribs 140 which are connected to and protrude outwardly from the side wall 26 of the core barrel 14. Complementary radially inwardly directed slots 142 are provided at circumferentially spaced positions on the upper support ring 72 within which slots portions of the ribs 140 are receivable.

It will be appreciated that, in normal use, there will be some relative movement between the core barrel 14 and the reactor pressure vessel 12, e.g. as a result of changes in temperature, differential rates of expansion and the like. The clearance between the support beams 54 and the lower support ring 134 and between the ribs 140 and the upper support ring 72 will be selected to permit this relative movement. In order to obtain the desired clearance in the slots 138, 142, use is made of shims 144, one of which is shown in Figure 6 of the drawings. The shims are machined to the required dimensions and installed on the lower support ring 134 and upper support ring 72 to provide the desired clearance between the ends of the support beams 54 and the ribs 140, respectively. As can best be seen in Figure 6 of the drawings, each shim 144 includes an end plate 160

and a body portion 162 protruding from the end plate 160. Oppositely disposed parallel ribs 164 protrude laterally outwardly from the body 162 and are slidably receivable in complementary vertically extending oppositely inwardly disposed channel formations in the support rings 72, 134. The shims are retained in this position by means of screws 166 which extend through complementary holes 168 in protruding portions of the end plates 160.

The core barrel typically has a length of about 22 meters and a circumference of about 18 meters. The core barrel heats up during operation and cools down during shut-down. In order to remain within the material temperature constraints, the core barrel has to be cooled down on the outside and to this end a core barrel cooling system is provided. However, it is unlikely that the core barrel sides will be at a uniform temperature all around the circumference at any given height. Variations in temperature can result from various factors such as an uneven flow of the core barrel cooling system gas around the circumference of the core barrel, an uneven gap between the side reflector and the core barrel sides, e.g. because of manufacturing tolerances, an uneven gap between the reactor pressure vessel and the core barrel due to manufacturing tolerances on both of these components, un-symmetrical placement of components such as inlet- and outlet pipes, or the like. An uneven temperature distribution on the core barrel may result in some lateral deformation of the core barrel, e.g. slight bowing thereof. By supporting the weight of the core barrel on the single centrally disposed vertical support 16, the core barrel may bow without any exceptional stresses being induced in the core barrel or the support structure. This makes the core barrel insensitive to an uneven temperature distribution. A disadvantage with the prior art is that the core barrel is supported at a plurality of spaced apart vertical supports. As a result of movement of the core barrel uneven loading of the supports and hence of the core barrel

can occur which can lead to undesirably high levels of stress. This problem is avoided by making use of the single centrally disposed vertical support 16.

Further, naturally, as a result of differences in temperature as well as the materials used, the rates and extent of the expansion of the core barrel and the reactor pressure vessel may differ. In this regard, the lateral support 76 serves to support the upper end of the core barrel. As the core barrel heats up, it expands both vertically and radially. This results in the inner support members 78 being displaced upwardly and radially outwardly relative to the outer support members 80. However, the inclination of the support surfaces 82, 84 permits this expansion and maintains the support surfaces in contact with the surface of the roller 86. The natural resilience of the guide beams 108 also permits a degree of lateral movement. If, for some reason, the surfaces 82, 84 lose contact with the roller 86, the roller will be held in position by means of the gear teeth 92, 98. Should the separation between the surfaces 82, 84 become even greater such that the teeth 92, 98 lose contact, then the roller will roll down the surface 84 until the projections 94 are positioned in the bottom of the slots 102. This ensures that the rollers 86 do not fall down between the reactor pressure vessel 12 and core barrel 14. The surfaces 82, 84 are typically inclined at an angle of about 10° to the vertical. However, it will be appreciated, that this angle may vary with the optimum for a particular application being determined by routine experimentation.

In the event of an unusual load being applied to the reactor 10, e.g. as a result of a seismic event, the single vertical support 16 will support the weight of the core barrel 14, however, the lateral supports 76 may be incapable of providing sufficient horizontal support to the core barrel 14 since the guide beams 108 will deform. If the deflection is sufficient, the gaps between the end portions of the support beams 54 and the slots 138

and between ribs 140 and the slots 142 will close thereby transmitting horizontal loads from the core barrel 14 to the reactor pressure vessel 12. After the seismic event, the guide beams 108 will centralize the core barrel 14 and open up the gaps between the ribs 140 and the slots 142. In this regard, it will be appreciated that the guide beams 108 are designed to handle this deformation and remain within the elastic region of the material from which they are manufactured.

Naturally, certain variations of the support arrangement are possible. For example, the lower support member 46 can be connected to the reactor pressure vessel by means of a configuration of beams designed to spread the load transmitted thereto by the core barrel over a larger area of the reactor pressure vessel.

Another variation of the support arrangement is illustrated in Figure 13 of the drawings in which reference numeral 200 refers generally to part of another reactor incorporating a support arrangement in accordance with the invention and, unless otherwise indicated, the same reference numerals used above are used to designate similar parts.

The main difference between the support arrangement of the reactor 200 and that of the reactor 10 is that, in the case of the reactor 200 the support arrangement includes an intermediate member 202 disposed between the upper support member 44 and the lower support member 46. The intermediate member 202 is generally oval in shape having convex upper and lower contact surface 204, 206. The upper support member 44 and lower support member 46 have concave support surfaces 208, 210. The radii of the support surfaces 208, 210 are larger than those of the support surfaces 204, 206. Radially inner ends of the beams 54 serve to retain the intermediate member 202 in position.

An advantage with this arrangement is that it is self-centering.

The Inventor believes that when compared with prior art systems, the current invention will result in lower stresses on a vessel which is subjected to temperature fluctuations as well as on the support structure. Further, in the specific case of a reactor it allows a small amount of bowing of the core barrel without an increase in stresses. The core barrel is able to tolerate an uneven temperature distribution. Further, the core barrel can expand radially relative to the reactor pressure vessel as well as axially. By permitting adjustment of the supports 104, the lateral support of the core barrel adjacent its upper end can be adjusted to make sure that the core barrel is self-aligning and stable. Further, the shims which are provided on the upper and lower support rings are sized during installation and thereby ensure that the desired spacing or tolerances are achieved.

DATED THIS 15TH DAY OF AUGUST 2003

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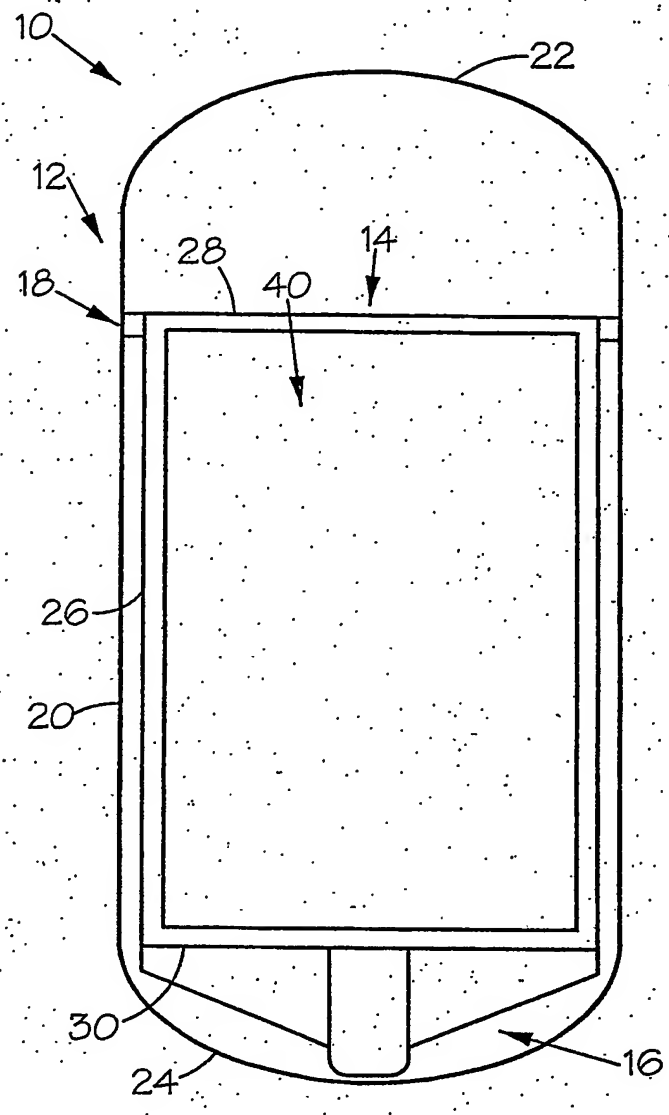

FIG 1

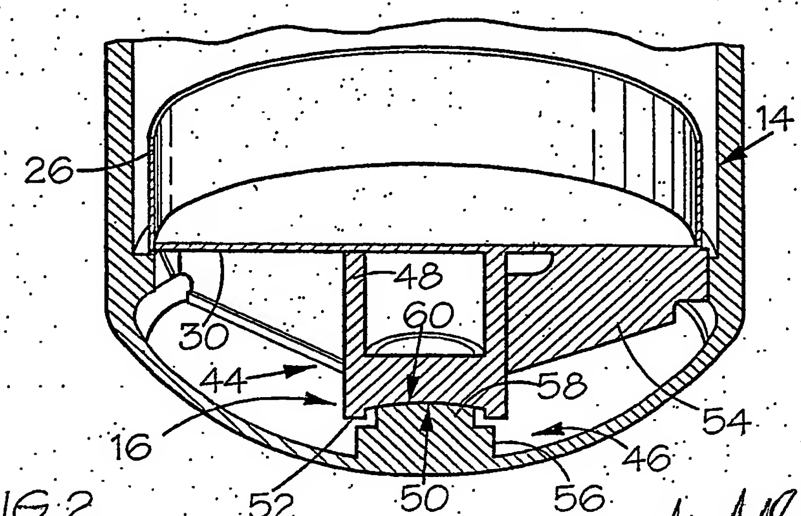

FIG 2

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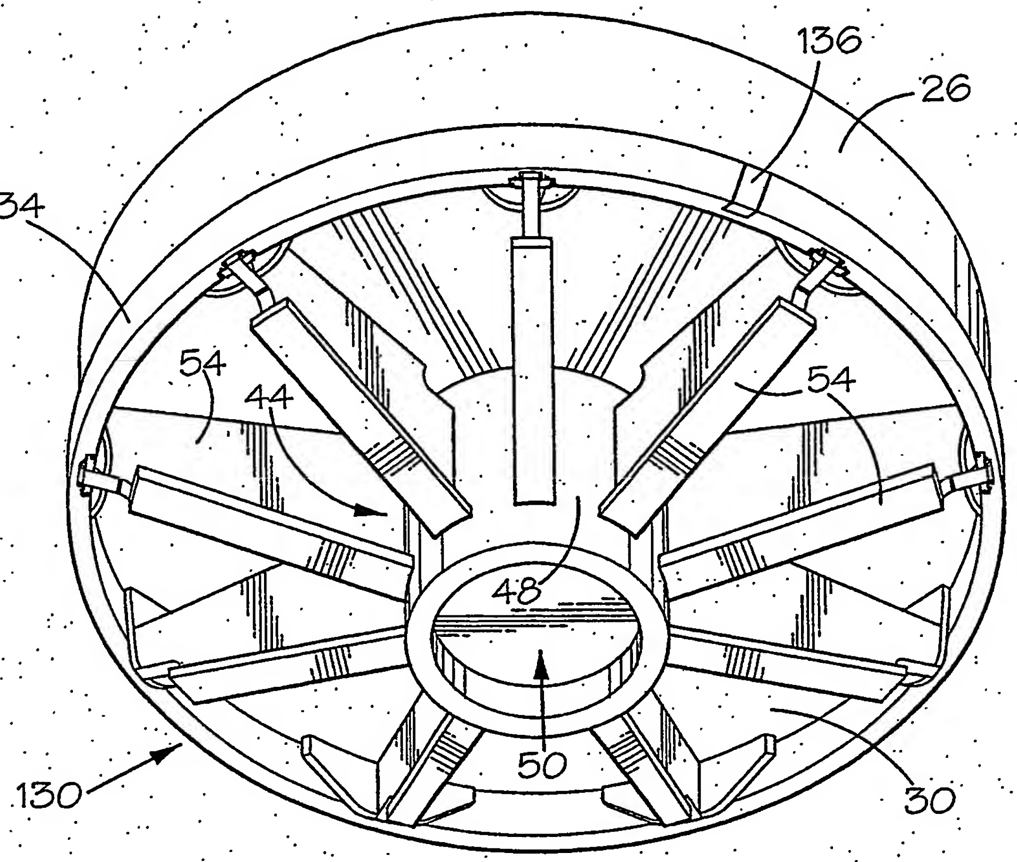

FIG 3

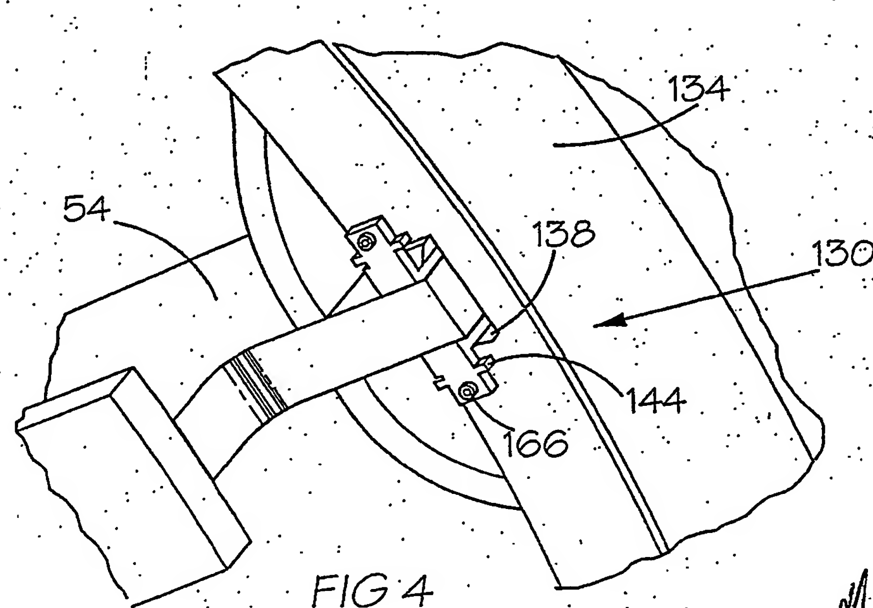

FIG 4

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2003/6376

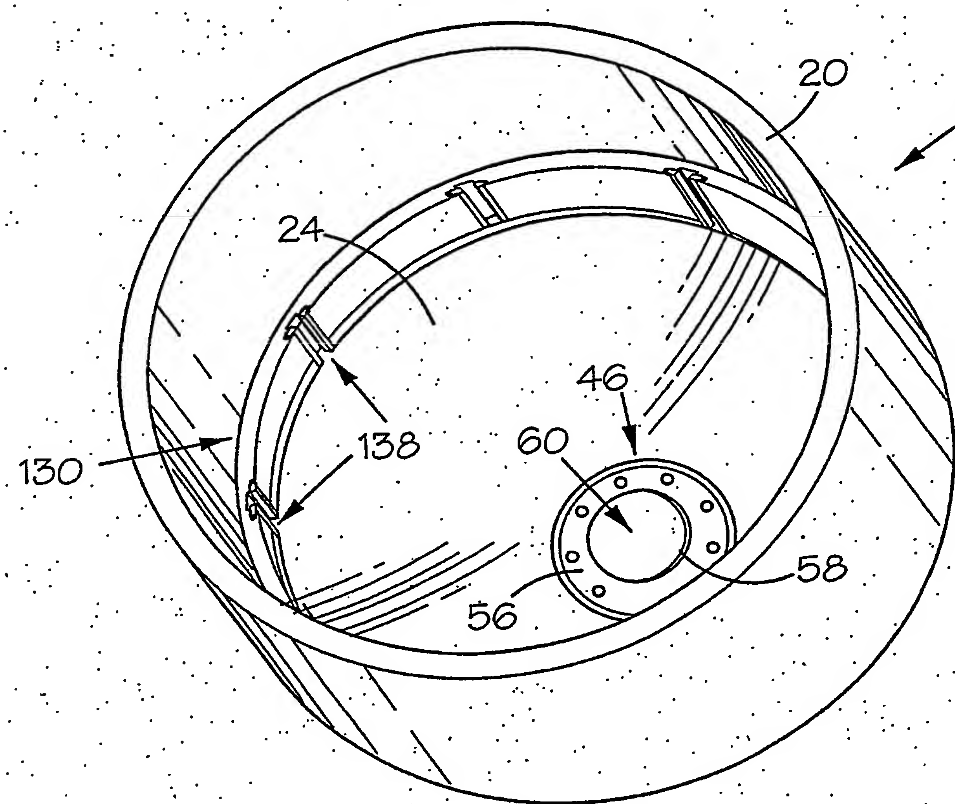

FIG 5

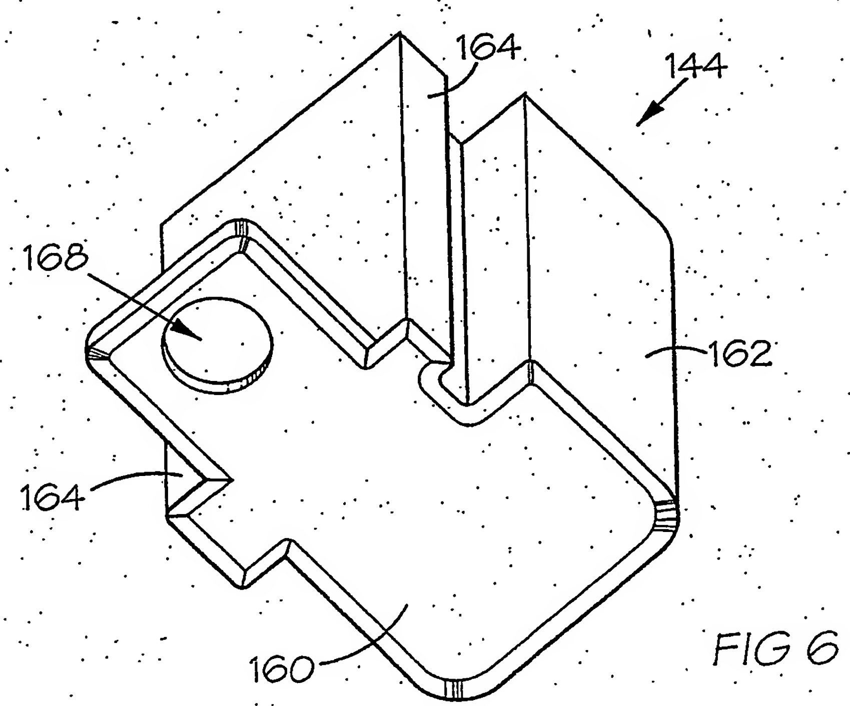

FIG 6

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APPLICANTS PATENT ATTORNEYS

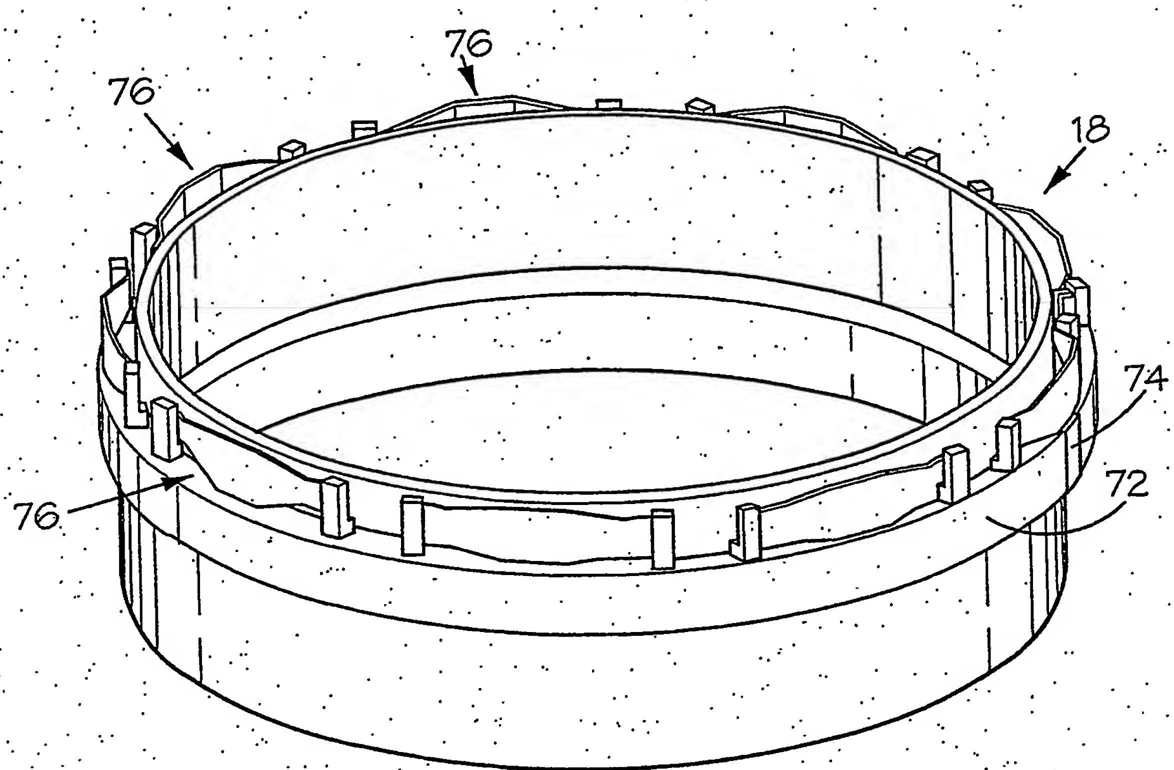

FIG 7

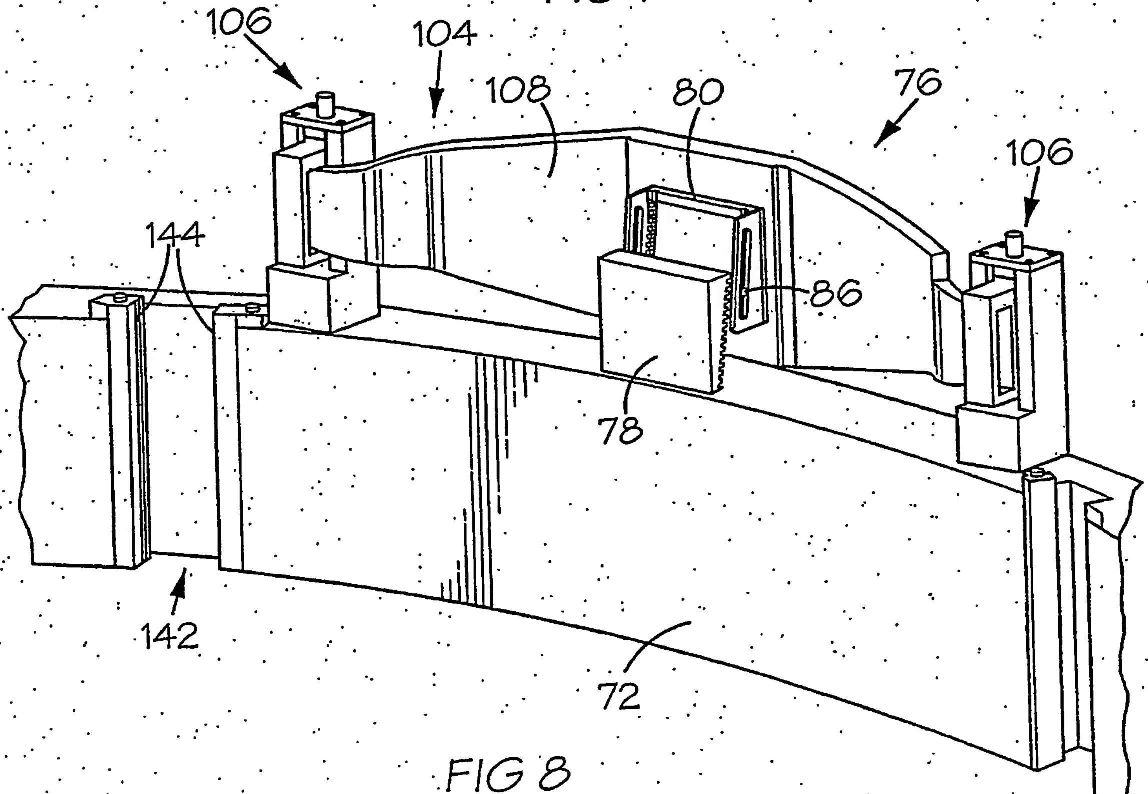

FIG 8

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APPLICANTS PATENT ATTORNEYS

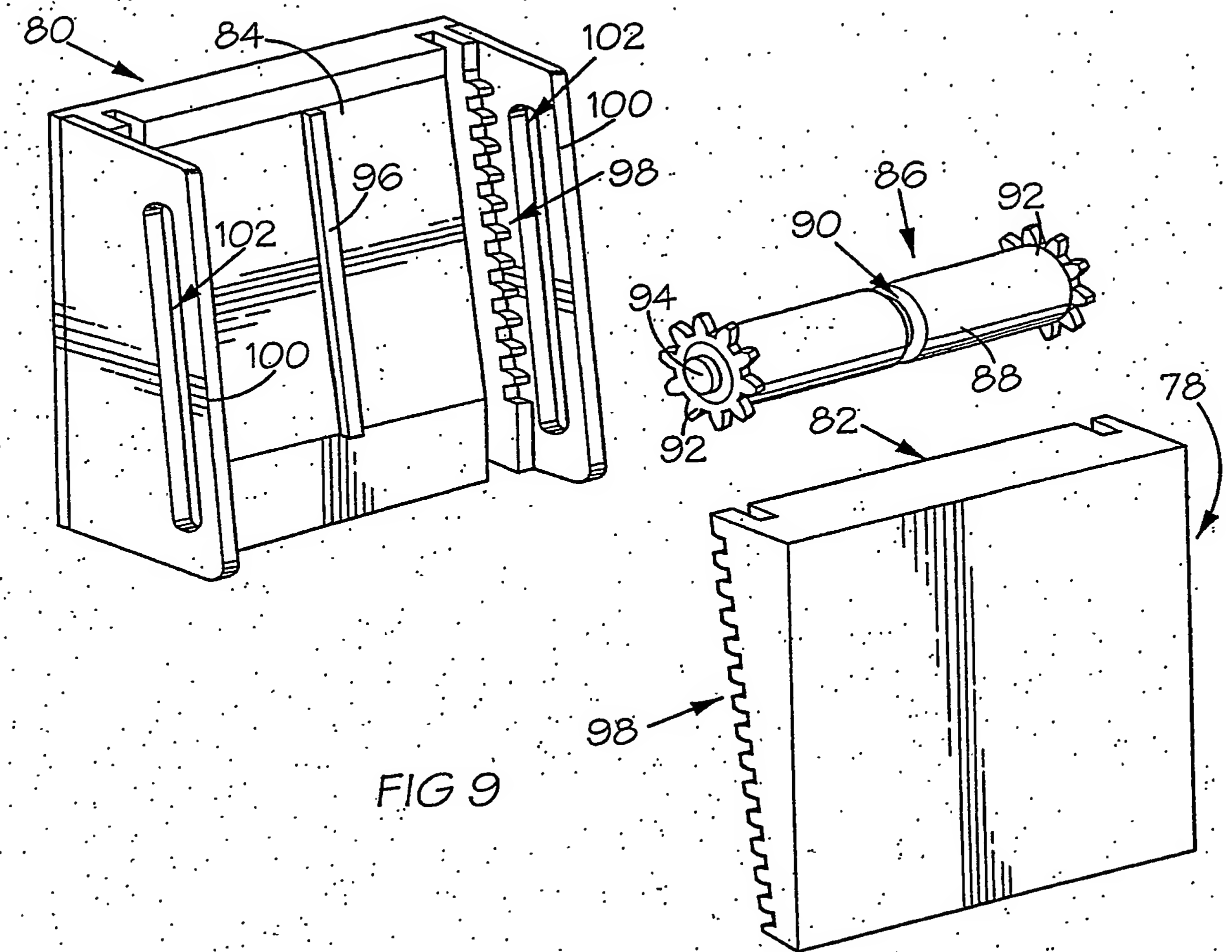

FIG 9

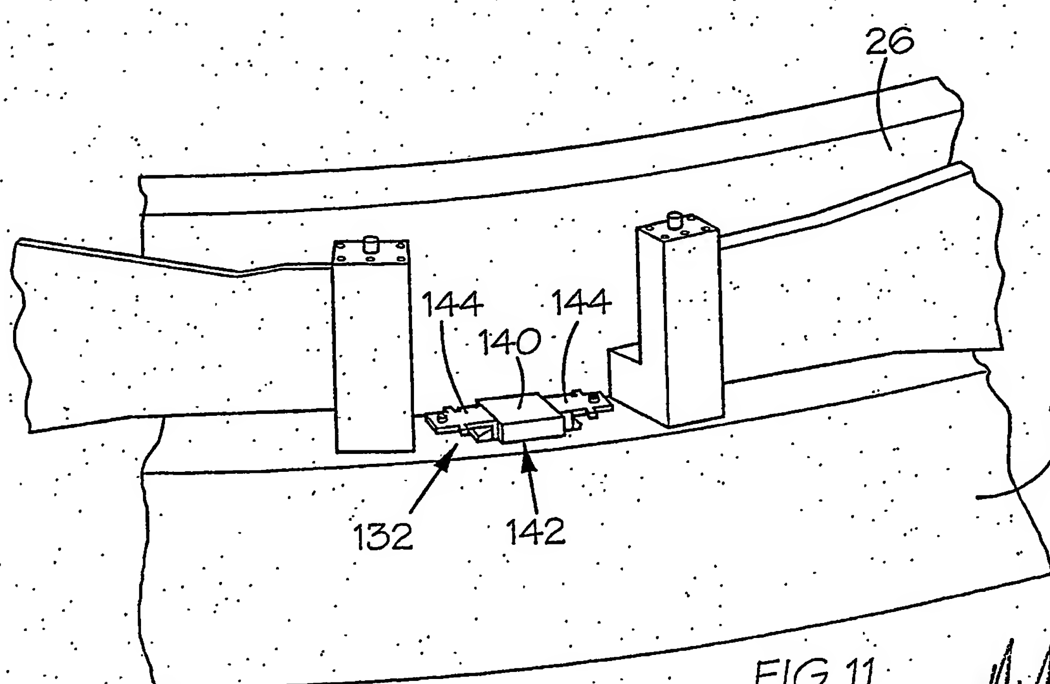

FIG 11

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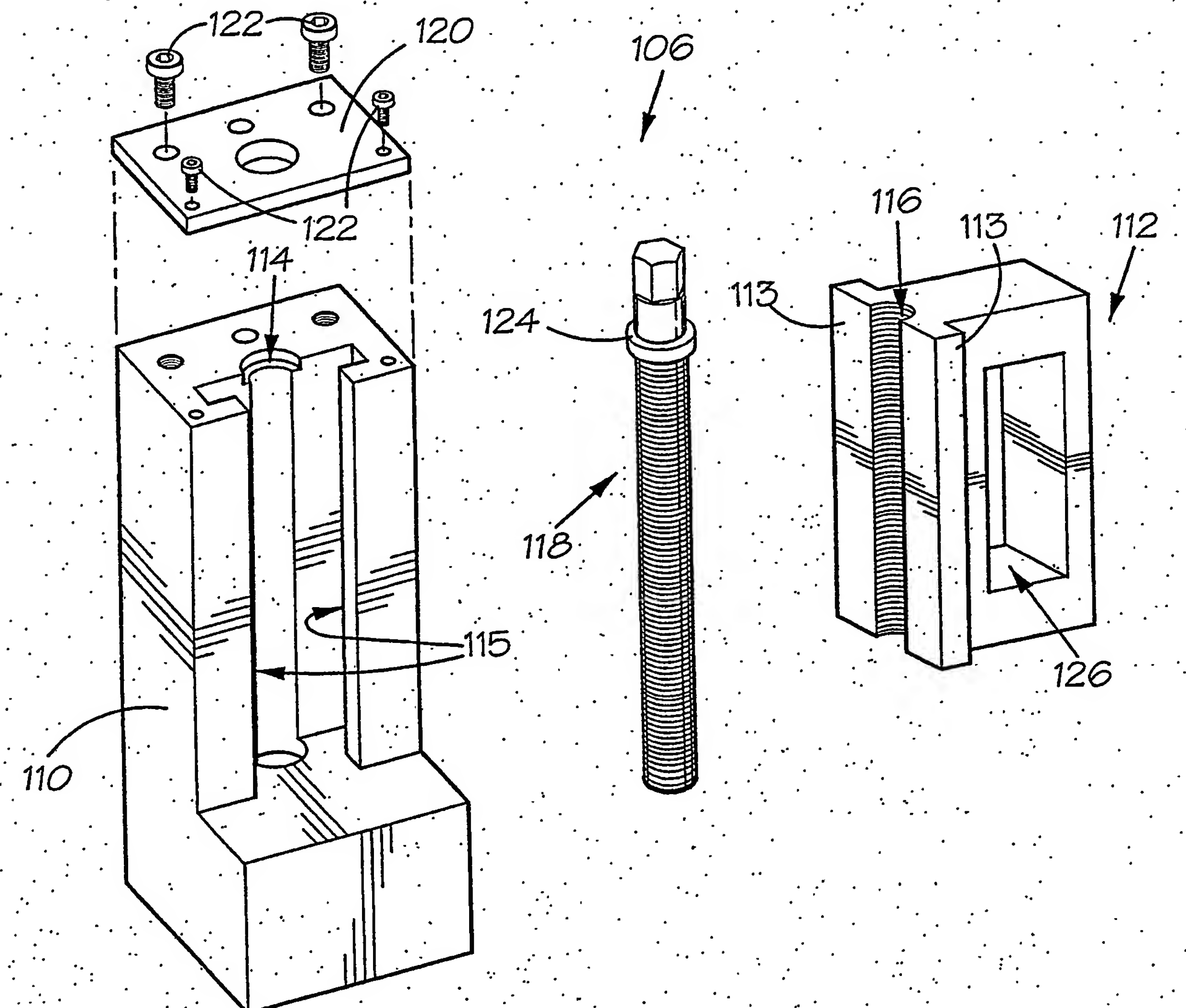

FIG 10

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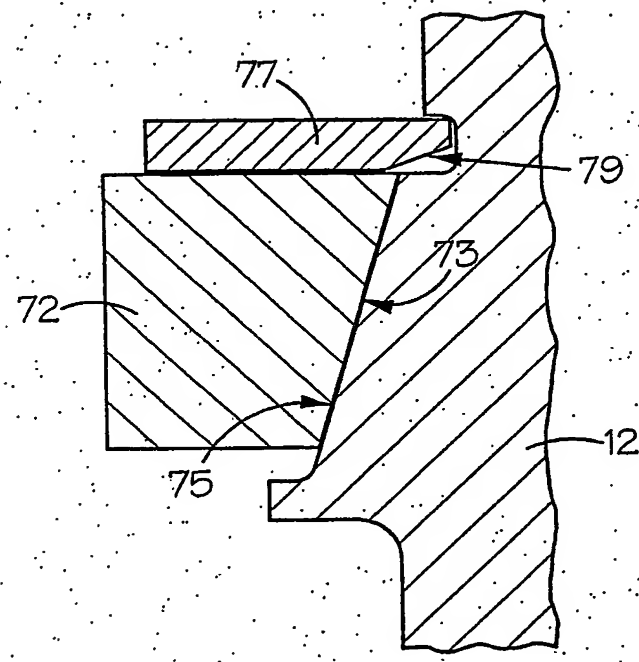

FIG 12

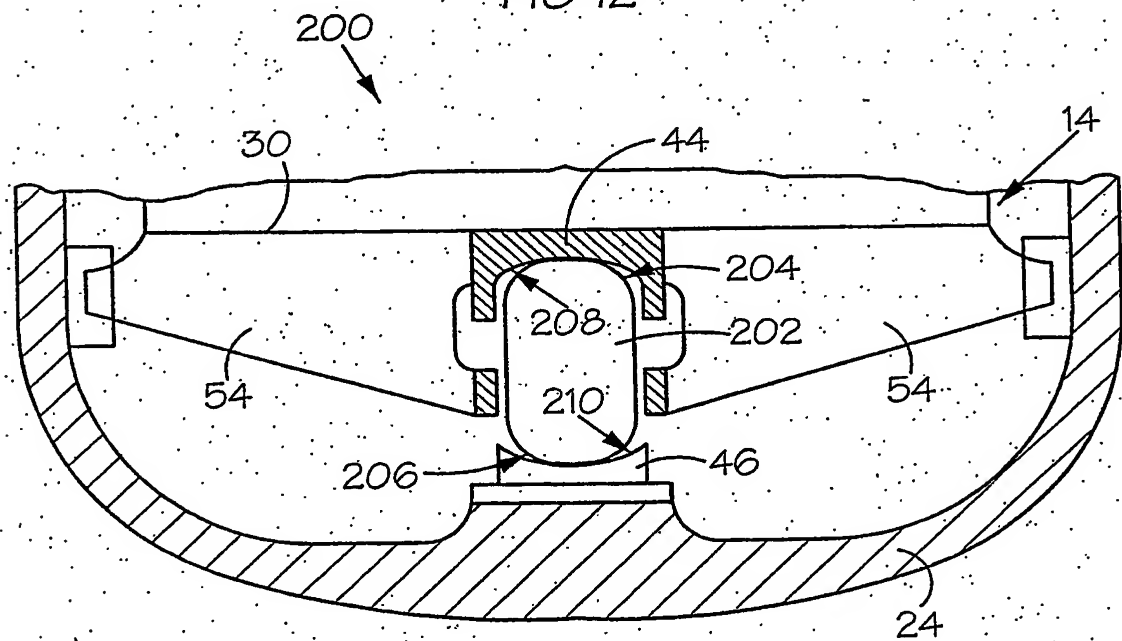

FIG 13

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